Ankyra Medical Journal
ORIGINAL ARTICLE DOI: 10.51271/ANKMJ-0009

The relationship between anterior fontanelle and head circumference in term newborns

Ramazan Dulkadir[1], Bahar Çuhacı Çakır[2], Aysu Duyan Çamurdan[2]

[1]Department of Pediatrics, Kırşehir Ahi Evran Training and Research Hospital, Kırşehir, Turkiye
[2]Department of Social Pediatrics, Faculty of Medicine, Gazi University, Ankara, Turkiye

Cite this article: Dulkadir R, Çuhacı Çakır B, Duyan Çamurdan A. The relationship between anterior fontanelle and head circumference in term newborns. *Ank Med J.* 2024;3(2):46-48.

Received: 01/03/2024 ◆ **Accepted**: 20/03/2024 ◆ **Published**: 26/03/2024

ABSTRACT

Aims: At birth, infants have membranous cavities called fontanelles because the angles of the skull bones have not yet formed. Its size is generally accepted as an indicator of cranial development and bone maturation. Head circumference measurement is an important marker for predicting brain development, especially in early childhood.

Methods: Patients followed up in the pediatric outpatient clinic of Kırşehir Training and Research Hospital between January 2020 and January 2024 were retrospectively analyzed. Anterior fontanelle width and head circumference measurements of babies born on the day recorded in the system were recorded.

Results: A total of 340 (M/F:188/152) patients were included in the study. There was a positive correlation between fontanel width and head circumference at birth, at 1 month and at 2 months ($p<0.05$). There was no correlation between fontanel width and head circumference at 3, 4, 6, 9, 12 months ($p>0.05$).

Conclusion: A significant relationship was found between anterior fontanelle width and head circumference in the first months of life. It is considered to be taken into consideration in the follow-up of healthy children. However, further studies are needed in this context and our study will contribute to future studies.

Keywords: Child, anterior fontanel, head circumference

INTRODUCTION

At birth, infants have membranous cavities called fontanelles because the angles of the skull bones have not yet formed. The largest and systematically palpated anterior fontanelle (ACF) is diamond-shaped.[1] Its dimensions and closure are evaluated by physical examination.[2] The mean anteroposterior diameter is 1.5-2.5 cm closure, which begins around the 3rd month after birth, is commonly regarded as a marker of cranial growth and ossification.[1-3] An increase in anterior fontanelle size may reflect increased intracranial pressure, osteogenesis imperfecta, achondroplasia, hypothyroidism or other skeletal system anomalies, whereas a decrease may reflect craniosynosis, hyperthyroidism and microcephaly.[3-4] Its width is evaluated by palpation under the scalp in the form of a rhombus on physical examination. Head circumference measurement is an important marker in predicting brain development especially in early childhood.[10-11] Abnormal values in head circumference (microcephaly, macrocephaly) may be an early harbinger of many diseases including developmental retardation and may also be familial. Heritability estimates for head circumference variation show that approximately half of normal head circumference variations are familial and are most likely genetically determined.[12]

In this study, our primary objective was to investigate the potential correlation between fontanelle size and head circumference in healthy infants.

METHODS

Our study was conducted by retrospectively examining the follow-ups of healthy infants admitted to the Pediatric Outpatient Clinic of Kırşehir Training and Research Hospital between January 2020 and January 2024 and recording anterior fontanelle and head circumference data. In your outpatient clinic, newborn babies are typically examined at birth and during the first week, followed by monthly check-ups for the first 6 months, then every 3 months until 18 months, and finally every 6 months until they reach 5 years of age. Infants who attended regular child health follow-up were included in the study. The study included infants with a gestational age between 36 and 40 weeks, normal birth weight for gestational age (AGA), and no prenatal, natal, or postnatal medical issues. Infants outside this gestational age range, with small (SGA) or large (LGA) birth weight for gestational age, or with chronic diseases or congenital anomalies, were excluded from the study. The study gathered and documented data from 340 robust, full-term

Corresponding Author: Ramazan Dulkadir, drrdulkadir40@hotmail.com

This work is licensed under a Creative Commons Attribution 4.0 International License.

newborns who satisfied the inclusion criteria for subsequent analysis. Head circumference data were used, which included longitudinal and transverse measurements of the anterior fontanelle and measured using a narrow, non-stretchable tape passing over the supraorbital processes on the child's forehead and the occiput posteriorly. Anterior fontanelle patency was evaluated by physical examination and fontanelle dimensions were calculated by dividing the sum of anteroposterior and transverse dimensions by 2 using the method described by Popich and Smith.[5]

The study received ethical clearance from the Ahi Evran University Faculty of Medicine Ethics Committee (Date: 20.02.2024, Decision No: 2024-05/33). The research adhered to the ethical guidelines outlined in the Declaration of Helsinki.

Statistical Analysis

The statistical analyses for the study were carried out utilizing the Statistical Package for Social Sciences version 25.0 software for Windows (IBM SPSS Statistics for Windows, Version 25.0, IBM Corp., Armonk, NY, USA). The normality assumption was assessed using both the Kolmogorov-Smirnov and Shapiro-Wilk tests. The descriptive statistics of the variables were presented as mean±standard deviation and median (min-max). Group comparisons were assessed using the Kruskal-Wallis test. For post hoc comparisons of groups with significant differences, the Mann-Whitney U test, which is the post hoc test for the Kruskal-Wallis test, was employed. The relationships between variables were examined using Spearman correlation analysis and ANOVA. A significance level of $p<0.05$ was considered statistically significant for all analyses.

RESULTS

In the study, a total of 340 patients were enrolled, with 55.3% (n=188) being boys and 44.7% (n=152) girls.

The fontanelle width was larger in boys than in girls, but there was no difference between the sexes in head circumference (Table 1). In the study conducted by the user, a positive correlation was observed

Table 1. Distribution of cases according to fontanel and head circumference width

	Average	Standard deviation	p
Fontanel width (cm)	155.9043 (Male)	22.14395	>0.05
	148.5526 (Female)	24.76801	
Head circumference	313.8989 (Male)	8.86593	
	312.0066 (Female)	7.92556	

between fontanelle width and head circumference at birth, at 1 month, and at 2 months ($p<0.02$, $p<0.15$, $p<0.36$) (Table 2). In the study, there was no correlation found between fontanelle width and head circumference at 3, 4, 6, 9, and 12 months. ($p>0.96$, $p>0.141$, $p>0.141$, $p>146$, $p>0.439$, $p>0.88$) (Table 2). Additionally, in the user's study, there was no correlation observed between fontanelle width and head circumference when all the evaluated months were combined and analyzed together. ($p>0.85$) (Table 2).

DISCUSSION

Since an abnormal fontanelle in infants may indicate serious problems, evaluation of the fontanelle is part of the routine physical examination.

Table 2. Relationship between fontanel and head circumference of the cases according to months

	Fontanel/head circumference ratio by months	p
FC0/BC0	181.469 a	.002
FC1/BC1	173.508 a	.015
FC2/BC2	181.743 a	.036
FC3/BC3	49.147 a	.969
FC4/BC4	359.113 a	.141
FC6/BC6	159.823 a	.146
FC9/BC9	102.826 a	.439
FC12/BC12	222.561 a	.088
FC Total/BC total	17924.154 a	.854

a: R Squared=.049 (Adjusted R Squared=.037), FP: Fontanel diameter, WC: Head circumference

There are various studies showing the anterior fontanel (ACF) dimensions in infants. Boran P. et al.[11] used the Popich method to determine the size of the ACF in 321 healthy term infants from birth to 24 months and created percentage charts. In this study, they reported the mean fontanel closure time as 9.7±5.0 months.

In a study conducted by Neyzi et al.[12] in our country, the difference between the head circumferences of boys and girls was 0.4 cm at birth and 1.3 cm at 12 months and 24 months . In our study, although head circumference was larger in boys than in girls, no significant difference was found (Table 1).

It has been observed that there is a difference between anterior fontanel dimensions and races.[13]

When the time of fontanel closure was examined in studies, it was found that fontanelles were still open at the age of 2 years.[14-15] The common result of these studies was that fontanel dimensions increased between 0-2 months and reached the highest value in the 2nd month and then gradually decreased.[18-19] In our research, fontanel dimensions were found to be larger in the first two months compared to the other months. In one study, the anterior fontanel width was found to be significantly larger in male newborns than in female newborns.[24] In addition, fontanel width was found to be larger in boys than in girls. No other study has been found to investigate whether there is a relationship between head circumference and fontanel width. In our study, a significant relationship was identified between fontanelle width and head circumference during the first two months of life. However, no correlation was found in the other months of follow-up. When we analyzed whether there was a relationship between head circumference and fontanel width in all the months followed up, no significant result was found. In a recent study, birth weight and head circumference were found to be risk factors for anterior fontanelle width.[25]

Duc and Largo[4] also found that the percentage of closed fontanelles was higher in boys than in girls, although not statistically significant. Similar findings regarding the higher percentage of closed fontanelles in boys compared to girls, without statistical significance, have been documented in other studies as well.[1-4,10,13,22]

About half of the normal variation in head size may have a familial component. Weaver and Christian did not find a significant maternal effect on the child's head size. However, they observed that mothers of children diagnosed with microcephaly also had microcephaly, while fathers of children with macrocephaly also had macrocephaly.[20]

Maternal nutrition has been found to have an effect on head circumference.[23]

In patients with an abnormal fontanelle, ultrasonography (US), CT and magnetic resonance imaging (MR) can be used to evaluate ventricular dimensions and subarachnoid distance widths, and to exclude space-occupying lesions and many other pathologies. However, US is preferred in patients with an open fontanelle because of the disadvantages of CT including radiation exposure and MR including cost and sedation.[3-6,16,17,21] Fontanelle abnormalities constitute a significant portion of patients referred to radiology for transfontanel US. It is important to know the normal distribution in order to detect abnormal fontanelle and to refer the patient for imaging to exclude pathologies that may cause this abnormality. In addition, head circumference follow-up is extremely important for the early diagnosis of future pathologies.

CONCLUSION

Regular follow-up of fontanelle opening and head circumference is extremely important in the follow-up of healthy children. There is no previous study investigating the relationship between fontanel width and head circumference. Our study is the first in this sense. In our research, a significant relationship was identified between fontanelle width and head circumference during the first two months of life. However, further studies are needed to reinforce this finding.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of Ahi Evran University Faculty of Medicine Ethics Committee (Date: 20.02.2024, Decision No: 2024-05/33).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Amiel-Tison C, Gosselin J, Infante-Rivard C. Head growth oath cranial assessment at neurological examination in infancy. *Dev Med Child Neurol*. 2002;44(9):643-648.
2. Fleming Salvador Pedroso FS, Rotta N, Quintal A, Giordani G. Evolution of anterior fontanel size in normal infants in the first year of life. *J Child Neurol*. 2008;23(12):1419-1423.
3. Kiesler J, Ricer R. The abnormal fontanel. *Am Fam Physician*. 2003;67(12):2547-2552.
4. Duc G, Largo RH. anterior fontanel: size and closure in term oath preterm infants. *Pediatrics*. 1986;78(5):904-908.
5. Popich GA, Smith DW. Fontanels: range of normal size. *J Pediatric*. 1972;80(5):749-752.
6. Khosroshahi N, Nikkhah A. Benign enlargement of subarachnoid space in infancy : "a review with emphasis on diagnostics work-up". *Iran J Child Neurol*. 2018;12(4):7-15.
7. Pindrik J, Ye X, Ji BG, Pendleton C, Ahn ES. anterior fontanelle closure and size in full-term children based on head computed tomography. *Clin Pediatr*. 2014;53(12):1149-1157.
8. Wu T, Li HQ. Changes in anterior fontanelle size in children aged 0 to 2 years. *Chin J Pediatr*. 2012;50(7):493-497.
9. Lyall H, Ogston SA, Paterson CR. Anterior fontanel size in Scottish infants. *Scott Med J*. 1991;36(1):20-22.
10. Malas MA, Atas E. Determination of anterior fontanelle oath skull morphologies of premature oath term newborns according to Ibid oath sex oath investigation of the relationship between them. *Selçuk Tıp Derg*. 2000;16(2):71-77.
11. Boran P, Oğuz F, Furman A, Sakarya S. Evaluation of fontanel size variation oath closure time in children followed up from birth to 24 months. *J Neurosurg Pediatr*. 2018;22(3):323-329.
12. Neyzi O, Günöz H, Furman A, et al. Body weight, height, head circumference and body mass index refence values in Turkish children. *J Pediatr*. 2008;51(1):1-14.
13. Omotade OO, Kayode CM, Adeyemo AA. Anterior fontanelle size in Nigerian children. *Ann Trop Paediatr*. 1995;15(1):89-91. doi : 10.1080/02724936.1995.11747754. PMID: 7598443.
14. Winick M, Rosso P. Head circumference oath cellular growth of the brain in normal and marasmic children. *J Pediatr*. 1969;74(5):774-778. doi: 10.1016/S0022-3476(69)80140-X
15. Pedroso FS, Rotta N, Quintal A, Giordani G. Evolution of anterior fontanelle size in normal infants during the first year of life. *J Child Neurol*. 2008;23:1419-1423.
16. Noorizadeh N, Kazemi K, Grebe R, Helfroush MS, Wallois F. Evaluation of anterior fontanel size and area in the newborn using CT images. *J Intel Fuzzy Syst*. 2015;29(1):443-450.
17. Pindrik J, Ye X, Ji BG, Pendleton C, Ahn ES. Anterior fontanelle closure and size in full-term children based on head computed tomography. *Clin Pediatr*. 2014;53(12):1149-1157.
18. Esmaeili M, Esmaeili M, Ghane Sharbaf F, Bokharaie S. Fontanel size from birth to 24 months of age in Iranian children. *Iran J Child Neurol*. 2015;9(4):15-23.
19. Bartholomeusz HH, Courchesne E, Karns CM. Relationship between head circumference oath brain volume in healthy normal toddlers, children, and adults. *Neuropediatr*. 2002;33(5):239-241. doi: 10.1055/s-2002-36735
20. Weaver DD, Christian JC. Familial variation in head size and adjustment for parental head circumference. *J Pediatrics*. 1980;96:990-994.
21. Kirkpatrick J, Bowie S, Mirjalili SA. Closure of the anterior oath posterior fontanelle in New Zealand population: a computed tomography study. *J Paediatr Child Health*. 2019;55(5):588-593.
22. Mathur S, Kumar R, Mathur GP, Singh VK, Gupta V, Tripa-thi VN. Anterior fontanelle size. *Indian Pediatr*. 1994;31(2):161-164.
23. Miele MJ, Souza RT, Calderon IM, et al. Preterm SAMBA study group. Head circumference as an epigenetic risk factor for maternal nutrition. *Front Nutr*. 2022;9:867727. doi: 10.3389/fnut.2022.867727. PMID: 35923204; PMCID: PMC9340063.
24. Oumer M, Tazebew A, Alemayehu M. Anterior fontanel size among term newborns: a systematic review and meta-analysis. *Public Health Rev*. 2021;42:1604044. doi: 10.3389/phrs.2021.1604044. PMID: 34692179; PMCID: PMC8386755.
25. Cho KH, Kim JK, Kim ES. Anterior fontanel size in Korean nursery newborns and clinical implications of large anterior fontanel: a retrospective cohort, observational study. *Medicine*. 2023;102(22):e33882. doi: 10.1097/MD.0000000000033882. PMID: 37266654; PMCID: PMC10238034.